part6

Attachment
Exhibit No. 9E

16092087

Environmental Consulting & Technology, Inc.
7208 Falls of Neuse Road, Suite 102, Raleigh, North Carolina 27615
ECT No. 160213-0600

Air Permit Application for the C4GT Volume I—General Electric

Prepared for:

C4GT, LLC
Novi, Michigan

June 2016

Complex Challenges ... PRACTICAL SOLUTIONS

160920087

Document Review

The dual signatory process is an integral part of Environmental Consulting & Technology, Inc's (ECT's) Document Review Policy No. 9.03. All ECT documents undergo technical/peer review prior to dispatching these documents to any outside entity.

This document has been authored and reviewed by the following employees:

Joshua T. Ralph	Thomas O. Pritcher
Author	Peer Review
Joshua Ralph	Thomas Pritcher
Signature	Signature
June 20, 2016	June 20, 2016
Date	Date

Table of Contents

Table of Contents (Continued, Page 2 of 7)

Table of Contents (Continued, Page 3 of 7)

1 6 0 5 2 0 0 8 7

Table of Contents (Continued, Page 4 of 7)

1593287

Table of Contents (Continued, Page 5 of 7)

1609260087

Table of Contents (Continued, Page 6 of 7)

1609207

Table of Contents (Continued, Page 7 of 7)

List of Tables

169920087

List of Tables (Continued, Page 2 of 2)

List of Figures

List of Acronyms and Abbreviations

°F	degree Fahrenheit
$\mu g/m^3$	microgram per cubic meter
2×1	two-on-one
AAQS	ambient air quality standards
ARP	Acid Rain Program
BACT	best available control technology
bhp	brake-horsepower
Btu/kWh	British thermal unit per kilowatt-hour
C4GT	C4GT, LLC
CAA	Clean Air Act
CAIR	Clean Air Interstate Rule
CAM	compliance assurance monitoring
CCS	carbon capture and sequestration
CEMS	continuous emissions monitoring system
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CSAPR	Cross-State Air Pollution Rule
CT	combustion turbine
EPA	U.S. Environmental Protection Agency
FBN	chemically bound fuel nitrogen
ft	foot
g/bhp-hr	grams per brake-horsepower-hour
GCP	good combustion practices
GE	General Electric
GEP	good engineering practice
GHG	greenhouse gas
gr/100 dscf	grain per 100 dry standard cubic feet
GT	gas turbine
H_2O	water
H_2SO_4	sulfuric acid
HAP	hazardous air pollutant
HHV	higher heating value
HP	high-pressure
hr/yr	hour per year
HRSG	heat recovery steam generator
IP	intermediate-pressure
ISO	International Organization for Standardization

1692087

List of Acronyms and Abbreviations (Continued, Page 2 of 3)

kWe	kilowatt-electric
LAER	lowest achievable emission rate
lb	pound
lb/hr	pound per hour
lb/lb-mol	pound per pound-mole
lb/MMBtu	pound per million British thermal units
lb/MMcf	pound per million cubic feet
lb/MWh	pound per megawatt-hour
LP	low-pressure
MACT	maximum achievable control technology
MATS	mercury and air toxics standards
MMBtu/hr	million British thermal units per hour
MW	megawatt
N_2	molecular nitrogen
NAAQS	national ambient air quality standards
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NH_3	ammonia
NMHC	nonmethane hydrocarbon
NNSR	nonattainment new source review
NO	nitric oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxide
NSCR	nonselective catalytic reduction
NSPS	new source performance standards
NSR	new source review
O_2	oxygen gas
PM	particulate matter
PM_{10}	particulate matter less than or equal to 10 micrometers
$PM_{2.5}$	particulate matter less than or equal to 2.5 micrometers
ppb	part per billion
ppm	part per million
ppmv	part per million by volume
ppmvd	parts per million by volume, dry basis
Project	C4GT Project
PSD	prevention of significant deterioration
psia	pound per square inch absolute
PTE	potential to emit
RACT	reasonably available control technology
RBLC	RACT/BACT/LAER Clearinghouse
RMP	risk management program

List of Acronyms and Abbreviations (Continued, Page 3 of 3)

SAAC	significant ambient air concentration
scf/lb-mol	standard cubic foot per pound-mole
scf/MMBtu	standard cubic foot per million British thermal units
SCR	selective catalytic reduction
SER	significant emissions rate
SF_6	sulfur hexafluoride
SIC	Standard Industrial Classification
SIL	significant impact level
SIP	state implementation plan
SNCR	selective noncatalytic reduction
SO_2	sulfur dioxide
SO_3	sulfur trioxide
SR	State Road
tpy	ton per year
TSP	total suspended particulate
ULSD	ultra-low-sulfur diesel
VAC	Virginia Administrative Code
VDEQ	Virginia Department of Environmental Quality
VOC	volatile organic compound

1.0 Introduction

C4GT, LLC (C4GT), is proposing to construct and operate a combined-cycle combustion turbine (CT) electric generating facility in Charles City County, Virginia, herein referred to as the C4GT Project (Project). C4GT plans to build a two-on-one (2×1) power block (two CTs, two heat recovery steam generators [HRSGs], and one steam turbine) that operates in combined-cycle mode. C4GT is requesting an air quality permit that will allow two optional plant configurations. The CTs being considered for the proposed project are:

- Option 1—Two General Electric (GE) 7HA.02 units.
- Option 2—Two Siemens SGT6-8000H units.

Duct burners will be installed in the HRSGs of the proposed new units. Each CT generator and the duct burners will be capable of firing only pipeline-quality natural gas. The combined cycle CT generators will be equipped with selective catalytic reduction (SCR) to minimize nitrogen oxides (NO_x) emissions and an oxidation catalyst to minimize carbon monoxide (CO) and volatile organic compound (VOC) emissions.

The permit application document is presented in two volumes to differentiate between the two proposed plant configurations. Volume I, presented here, will detail operation of proposed Option 1, two GE 7HA.02 units. Volume II, presented in a separate document, details operation of the proposed Option 2, the operation of two Siemens SGT6-8000H units.

The proposed facility will also include several pieces of ancillary equipment, which will not change with the CT options. The list of equipment includes:

- One rated 105-million-British-thermal-units-per-hour (MMBtu/hr) (higher heating value [HHV]) natural gas-fired auxiliary boiler.
- One natural gas-fired dew point heater rated at 16 MMBtu/hr (HHV).
- One 18-celled cooling tower.

- One 3,633-brake-horsepower (bhp) (2,500 kilowatt-electric [kWe]) emergency generator operating on ultra-low-sulfur diesel (ULSD) fuel.
- One 315-bhp emergency firewater pump operating on ULSD fuel.

The proposed facility will be a "major" source of criteria air pollutants. C4GT is applying to the Virginia Department of Environmental Quality (VDEQ) for a prevention of significant deterioration (PSD) construction permit as required by VDEQ. VDEQ has a U.S. Environmental Protection Agency (EPA) state implementation plan (SIP)-approved PSD program. The proposed facility will not be a major source of hazardous air pollutants (HAPs).

This application addresses the permitting requirements specified by VDEQ under the Virginia Regulations for the Control and Abatement of Air Pollution, Title 9, Agency 5, Chapter 80, Virginia Administrative Code (VAC).

Please note that pending VDEQ's acceptance of the best available control technology (BACT) analysis and associated emissions rates and stack parameters, air dispersion modeling for the Project will be finalized and will be provided as an addendum to this application at a later date.

1.1 Applicant Information

To facilitate VDEQ's review of this document, an individual familiar with both the facility and the preparation of this application is identified in this subsection, along with C4GT's permitting consultant. VDEQ should contact these individuals if additional information or clarification is required during their review process. These contacts include contractors/consultants who have assisted with the preparation of this application under the direction of C4GT.

1.1.1 Applicant's Contact

The applicant contact information is as follows:

Anand Gangadharan
23955 Novi Road
Novi, Michigan 48375
(248) 735-6684

1.1.2 Permitting Consultant

The applicant's permitting consultant contact information is as follows:

Thomas O. Pritcher, P.E.
Environmental Consulting & Technology, Inc.
7208 Falls of Neuse Road, Suite 102
Raleigh, North Carolina 27615
(919) 861-8888 (Office)
(919) 631-1537 (Mobile)

1.2 Project Location

The proposed Project will be constructed in Charles City County approximately 16 miles southeast of Richmond, Virginia, along State Route (SR) 106, approximately 2,000 feet (ft) north and west of the intersection of SR 685 as shown in Figure 1-1. The site is approximately 88 acres in size and is currently undeveloped, consisting of a recently logged pine forest. Appendix D presents a detailed site plan for the proposed Project.

From review of the surrounding land use, it is noted that the immediate region surrounding the site is characterized as primarily rural. Within this predominantly rural area are forest/ undeveloped land and woody wetlands.

1.3 Facility Classification

There are two major classification criteria for the proposed Project, one related to its industrial character and the other to its potential to emit air contaminants. The designation of the facility under each of these is reviewed in the following subsections.

1.3.1 Industrial Classification Code

The United States government has devised the Standard Industrial Classification (SIC) code system, a method for grouping all business activities according to their participation in the national commerce system. The system is based on classifying activities into major groups defined by the general character of a business operation. For example, electric, gas, and sanitary services, which include power production, are defined as a major group. Each major group is

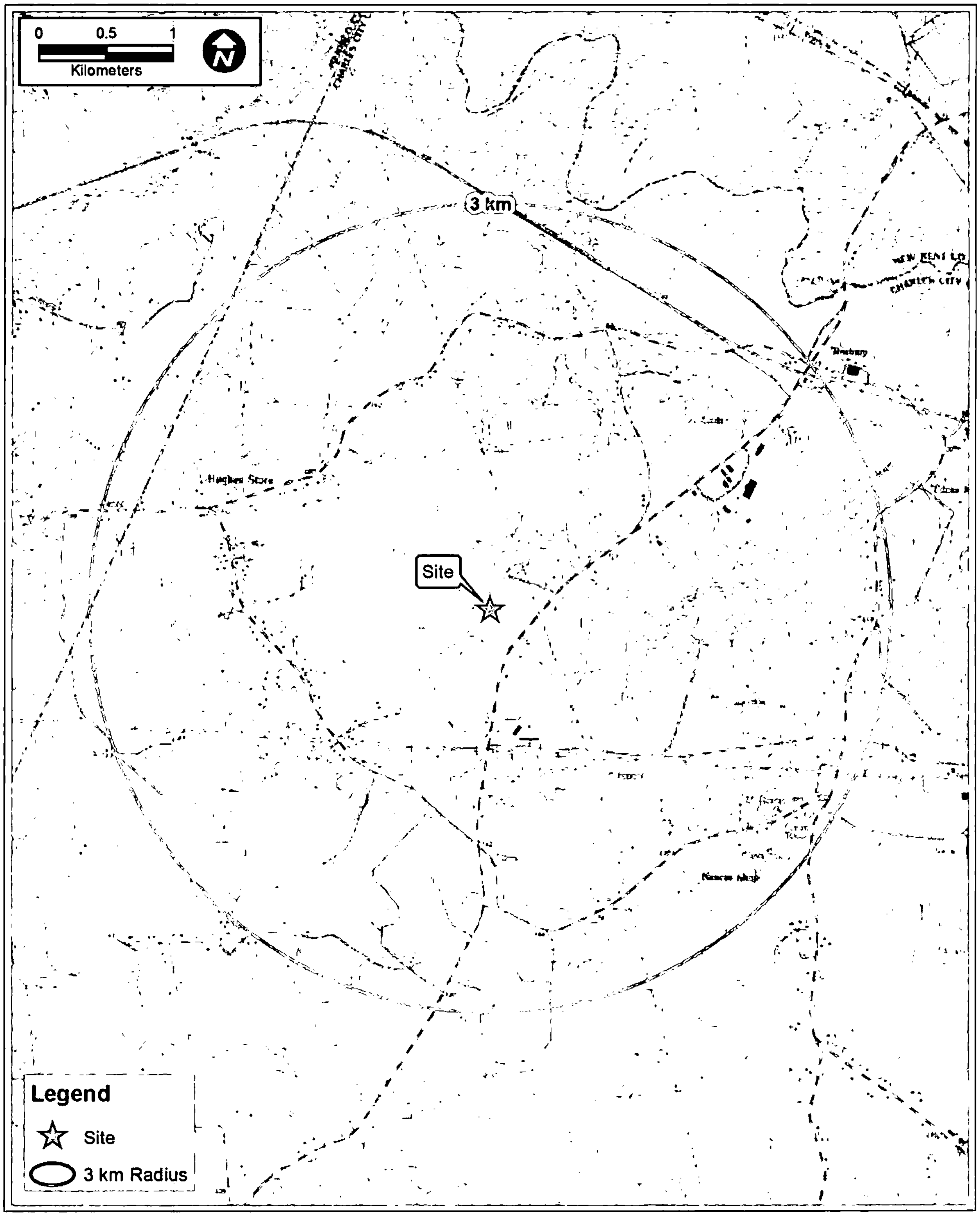

FIGURE 1-1.
SITE LOCATION TOPOGRAPHIC MAP

Sources: Esri Basemap, USGS Topographic Quadrangle; ECT, 2016.

Environmental Consulting & Technology, Inc.

given a unique two-digit number for identification. Power production activities have been assigned a major group code "49."

To provide more detailed identification of a particular operation, an additional two-digit code is appended to the major group code. In the case of power generation facilities, the two digit code is "11" to define the type of production involved.

The proposed Project is classified under the SIC code system as a major group of 49, electric, gas, and sanitary services, and then electric services of 11, or SIC 4911.

The North American Industry Classification System was introduced as a replacement for SIC codes in 1997. This system's organization is similar to SIC codes. Under this system, this facility would be classified as 221112, Fossil Fuel Electric Power Generation.

1.3.2 Air Quality Source Designation

With respect to air quality, new and existing industrial sources are classified as either major or minor sources based on their potential to emit (PTE) air contaminants. This classification is also affected in part by whether the area in which the source is located has attained National Ambient Air Quality Standards (NAAQS). An area is classified as attainment if the ambient air quality concentration for a specific pollutant, as measured by a monitor, is below the standard concentration level for a set of averaging periods. The area in which the proposed project is located is designated as attainment for all NAAQS in which EPA has issued a designation under Section 107 of the Clean Air Act (CAA).

For most activities, a major source is defined as one which has a PTE of 250 tons per year (tpy) of any regulated air contaminant. For a special group of 28 activities, EPA has defined the major source emissions threshold to be 100 tpy. Steam-electric power generation is one of these special groups. The proposed Project will be classified as a major stationary source of air emissions.

1.4 Document Organization

The balance of this document is divided into sections that address each component of the PSD air quality review process. The following list provides an overview of the contents of each of the remaining sections.

- Section 2.0: Process Description—General description of the primary combined-cycle processes by which power will be produced at this site, as well as a description of auxiliary and supporting equipment.
- Section 3.0: Emissions Summary—Detailed review of the air emissions during normal operations and startup/shutdown, tuning, and water wash operations that will occur at the Project site subsequent to completion of Project development.
- Section 4.0: Applicable Requirements and Standards—Discussion of applicable state and/or federal air regulations. The focus of this section will be on establishing which regulations are directly applicable to the proposed combined-cycle CT generators and the ancillary equipment and how compliance will be demonstrated.
- Section 5.0: Control Technology Review—Substantial requirement of the PSD program. Because the proposed Project will be classified as a major source and will result in a significant increase in the emissions of new source review (NSR)-regulated pollutants (as defined under PSD regulations), a detailed evaluation of control technologies is provided. Project emissions are projected to be significant for NO_X, particulate matter (PM), particulate matter less than or equal to 10 micrometers (PM_{10}), particulate matter less than or equal to 2.5 micrometers ($PM_{2.5}$), VOC, sulfuric acid (H_2SO_4), CO, and greenhouse gases (GHGs). As such, "top down" BACT analyses for these pollutants have been provided for each emissions unit.
- Section 6.0: PSD Class II Modeling Procedures—Summary of the dispersion modeling methodology and the manner in which the predicted impacts will be compared to the applicable standards. Specifically, this section discusses the modeling input data and various modeling scenarios evaluated.
- Section 7.0: Results of the Class II Area Significant Impact Level Analysis and Cumulative Impact Assessment Methodology—Results of the Class II area air dispersion analysis performed for the Project. This section compares predicted

impacts to applicable standards to demonstrate the Project will operate in compliance.

- Section 8.0: Class I Area Modeling Analysis—Results of the Class I area air dispersion modeling analysis performed for the Project.
- Section 9.0: Other Air Quality Issues—Supplemental information regarding the potential impacts of the Project. Specifically, this section discusses the potential for impacts to soils and vegetation and to the visibility of PSD Class I areas. Compliance with Virginia air toxics rules are discussed here as well.
- Section 10.0: References—List of the documents relied upon during preparation of this document.
- Appendices—Permit application forms, emissions calculations, supporting BACT information, figures and diagrams, dispersion modeling files on computer disc, and supplemental materials supporting the information presented herein:
    - Appendix A—Application Forms
    - Appendix B—Vendor Information and Emissions Calculations
    - Appendix C—Control Technology Review from EPA's RBLC
    - Appendix D—Plot Plan
    - Appendix E—Air Dispersion Modeling Files
    - Appendix F—Background Emissions Inventory
    - Appendix G—Air Quality Impacts, Contour Map

2.0 Process Description

2.1 Overall Description

As stated previously, C4GT plans to construct a facility in Charles City County, Virginia, with a 2×1 combined-cycle unit. Duct burners will be installed in the HRSGs. The Project is proposed with two CT options. This volume will only discuss Option 1 (GE 7HA.02). The key elements of the proposed project include:

- Two natural gas-fired 352-megawatt (MW) GE 7HA.02 CTs.
- Two natural gas-fired 475-MMBtu/hr (HHV) supplementary fired HRSGs, one for each CT generator.
- One reheat condensing steam turbine generator (unit has no emissions).
- Multiple-cell mechanical draft, counter flow, evaporative cooling tower system.
- One rated 105-MMBtu/hr (HHV) natural gas-fired auxiliary boiler.
- One natural gas-fired fuel gas heaters rated at 16 MMBtu/hr (HHV).
- One 3,633-bhp (2,500 kWe) emergency generator operating on ULSD fuel.
- One 315-bhp emergency firewater pump operating on ULSD fuel.

The proposed Project will have an approximate generating capacity of 1,060 MW-electric (nominally) at International Organization for Standardization (ISO) conditions with maximum duct firing. Each CT generator and duct burner will only be capable of firing pipeline-quality natural gas. The Project will employ BACT to minimize emissions of NO_x, PM, PM_{10}, $PM_{2.5}$, VOC, CO, sulfur dioxide (SO_2), H_2SO_4, and GHG.

2.2 Major Facility Components

The primary sources of pollutants associated with the proposed project are the two GE 7HA.02 CTs and the duct burners associated with the HRSG. Other sources of PSD pollutants associated with the proposed Project include a cooling tower, auxiliary boiler, fuel gas heater, emergency generator, and firewater pump. The following subsections provide brief descriptions of the major components of the Project.

2.2.1 CT Generators

The proposed Project includes the installation of two advanced GE 7HA.02 CTs in combined-cycle mode, each equipped with its own duct-fired HRSG that provides steam to a common steam turbine generator. The CT generators and duct-fired HRSGs will be fired using pipeline-quality natural gas. The CTs include internal cooling air passages in the CT to protect turbine blades from high firing temperatures, allowing for fast cold starts when compared with steam-cooled blades.

Maximum annual operation of each combined-cycle CT generator will be 8,760 hours per year (hr/yr). The CT generators will be equipped with SCR to minimize NO_x emissions and an oxidation catalyst to minimize CO emissions and VOC. Each CT generator power block includes an advanced H-class CT that incorporates elevated firing temperatures, air compressor section, gas combustion system (using dry low-NO_x combustors), power turbine, and a generator.

The CT is the main component of a combined-cycle power system. First, air is filtered and compressed in a multiple-stage axial flow compressor. Compressed air and fuel are mixed and combusted in the CT combustion chamber. Lean, premix, dry low-NO_x combustors minimize NO_x formation during combustion. Hot exhaust gases from the combustion chamber are expanded through a multiple-stage power turbine that results in energy to drive its own compressor and electric power generator.

The hot exhaust gas exiting the power turbine in the CTs is ducted to a HRSG, where steam is produced to generate additional electricity in a steam turbine generator. Duct burners located within the HRSGs are available for supplementary firing of natural gas to increase steam output.

The CTs are designed to operate in the dry low-NO_x mode at loads from approximately 50- up to 100-percent rating while firing natural gas. The CTs will be periodically taken out of service for scheduled maintenance or as dictated by economic or electrical demand conditions.

2.2.2 HRSGs

The HRSG is a triple pressure with reheat cycle and will be furnished by the CT manufacturer as part of the power island portion of the project. The HRSG will be located downstream of the gas turbine to capture the heat of the turbine exhaust for production of high-pressure steam. The HRSG will be furnished with a natural gas-fired duct burner to increase steaming capacity, SCR for NO_x abatement, and CO catalyst for emissions reduction. The HRSG will be furnished with superheating, reheating, and economizer sections required to achieve a highly efficient removal of heat from the CT gas stream and a low stack gas temperature.

Each HRSG includes a stack, with openings for monitors, sampling, and continuous emissions monitoring system (CEMS) as required by EPA.

Each HRSG is furnished with natural gas-fired duct burners, with all required burner safety valves and controls. Duct burners have a maximum heating capacity of 475 MMBtu/hr (HHV) for each HRSG.

An oxidation catalyst will reduce CO and VOC emissions of the gas turbine exhaust. The catalyst is located upstream of the SCR catalyst and ammonia (NH_3) injection grid and is designed to limit CO and VOC to 2 parts per million by volume, dry basis (ppmvd), at 15-percent oxygen gas during steady state operation.

An SCR system within each HRSG will reduce NO_x created by the gas turbine prior to exiting the stack. Aqueous ammonia vapor is injected upstream of the SCR, combining with NO_x at the catalyst to form water vapor. The ammonia originates from a storage tank containing 19-percent aqueous ammonia. The ammonia is pumped to a vaporizer at each HRSG, where it is vaporized and flows into an ammonia injection grid. Unit controls will feed the proper flow rate of ammonia to control NO_x emissions and limit ammonia slip. SCR is designed to limit NO_x to 2 ppmvd at 15-percent oxygen gas during steady-state operation.

2.2.3 Steam Turbine Generator

The steam turbine generator will be furnished by the CT manufacturer as part of the power island. The steam turbine will be a single-shaft turbine with high- (HP), intermediate- (IP) and low-pressure (LP) turbines, exhausting to a water-cooled condenser. Main steam will enter the HP turbine and will exit back to the HRSG cold reheat section. Hot reheat will enter the IP section of the turbine and will exhaust to the LP section of the turbine. The steam turbine rotates at synchronous speed. The steam turbine generator set is designed to produce a nominal 356 MW of electrical output at ISO conditions with duct firing.

2.2.4 Cooling Tower

The cooling tower is an evaporative, counter-flow tower, film fill, with back-to-back fan sections and internal spray header. The cooling tower is expected to have a recirculating flow rate of 348,500 gallons per minute and maximum 6,250 milligrams per liter of total dissolved solids. The cooling tower will be equipped with a high-efficiency drift eliminator with a drift rate of 0.0005 percent. The cooling tower is expected to have 18 cells.

2.2.5 Auxiliary Boiler

C4GT proposes to install an auxiliary boiler to supply sealing steam to the steam turbine generator at startup and at cold starts to warm up the steam turbine generator rotor and HRSG. The rated capacity of the natural gas-fired auxiliary boiler is proposed to be 105 MMBtu/hr. Ultra-low-NO_x burners will be used to control NO_x emissions from this unit. The steam from the auxiliary boiler will not be used to augment power generation of the CTs or steam turbine generator. C4GT requests the boiler be permitted to operate without annual operating restrictions, and the air quality modeling analysis reflects this assumption.

2.2.6 Dew Point Heater

C4GT proposes one 16-MMBtu/hr fuel gas heater. The heater will be used as a means to warm the incoming natural gas fuel to prevent freezing of the gas regulating valves under certain gas system operating conditions. The heaters will fire natural gas exclusively and use ultra-low-NO_x burners to control NO_x emissions. C4GT requests the heater be allowed to operate 8,760 hr/yr (i.e., without annual operating restrictions).

2.2.7 Diesel-Fired Emergency Generator

The proposed Project will include a 2,500-kWe emergency generator that will be powered by a 3,633-bhp diesel engine operating on ULSD fuel. The emergency diesel generator will provide power in emergency situations for turning gears, lubricating oil pumps, auxiliary cooling water pumps, and water supply pumps. The emergency diesel generator is not intended to provide sufficient power for a black start, peak shaving, or nonemergency power. The emergency generator will be operated up to 100 hr/yr for maintenance checks and readiness testing. Total annual operating hours, including emergency use, will not exceed 500 hr/yr and will include the 100-hr/yr maintenance and testing.

2.2.8 Diesel-Fired Firewater Pump

The proposed Project will include a 315-bhp diesel-fired engine operated as a firewater pump driver. The unit will be limited to 100 hr/yr for routine testing and maintenance. Total annual operating hours, including emergency use, will not exceed 500 hr/yr and will include the 100-hr/yr maintenance and testing.

2.2.9 Circuit Breakers

The proposed Project will include four switchyard circuit breakers and two low-side generator breakers. Each switchyard breaker will hold 1,900 pounds (lb) of sulfur hexafluoride (SF_6) per unit, while the smaller low-side generator breakers will hold 30 lb per unit. The Project's total SF_6 capacity will be 7,660 lb. The SF_6 leak rate will be limited to 0.5 percent annually.

2.2.10 Fuel Gas System

Pipeline-quality natural gas will be delivered to the plant boundary. Based on past experience, the natural gas companies that will potentially be supplying the natural gas for the Project will use odorized natural gas with a sulfur content up to 0.4 grain per 100 dry standard cubic feet (gr/100 dscf).

3.0 Project Emissions Summary

This section presents a summary, organized by emissions sources, of Project emissions and a discussion of the methodology used to calculate emissions. Within each emissions source subsection, the methods used to calculate emissions are discussed followed by a summary of the emissions estimates for the specific source, as well as, in the case of the CTs, mode of operation.

As indicated previously, the Project consists of the following sources of air emissions:

- Two natural gas-fired GE 7HA.02 CTs.
- Two natural gas-fired, 475-MMBtu/hr (HHV) supplementary fired HRSGs, one for each CT.
- One reheat condensing steam turbine generator (unit has no emissions).
- Multiple-cell mechanical draft, counter flow, evaporative cooling tower system.
- One rated 105-MMBtu/hr (HHV) natural gas-fired auxiliary boiler.
- One natural gas-fired fuel gas heater rated at 16 MMBtu/hr (HHV) each.
- One 3,633-bhp (2,500-kWe) emergency generator operating on ULSD fuel.
- One 315-bhp emergency firewater pump operating on ULSD fuel.

Emissions calculation procedures used in determining the potential emissions from the Project are based on CT information provided by the manufacturer, other equipment vendor data, emissions limitations specified by applicable new source performance standards (NSPS), emissions factors documented in EPA's "Compilation of Air Pollution Emissions Factors, AP-42," and proposed BACT emissions limits. Annual operational limitations have been accounted for while estimating potential annual emissions.

Appendix B presents detailed emissions calculations for each emissions source.

3.1 CT Generators

The primary sources of emissions at the site are the two CTs. The following subsections present maximum hourly emissions per CT during normal operations and startup/shutdown, tuning, and water wash events, as well as the total annual emissions for all two CTs, including startup/ shutdown, tuning, and water wash emissions. Appendix B provides additional details, such as emissions and flow calculations at various loads, ambient temperature, with and without evaporative cooling, and with and without duct burning.

3.1.1 Continuous Operations Scenario

Normal operation of a CT generator is characterized as continuous operation from minimum compliance load to 100 percent. Each of the two CTs is proposed to be operated up to 8,760 hr/yr with natural gas duct burner firing. Table 3-1 presents the maximum hourly emissions (pound per hour [lb/hr]) and the annual emissions (tpy) for PSD pollutants for two cases: natural gas combustion with and without duct burner firing.

3.1.2 Startup and Shutdown

C4GT proposes the following definitions and permit conditions for startup and shutdown events:

- Startup—The time from GT fire to HRSG stack emissions compliance:
  - Cold Startup—Restarts made 48 hours or more after shutdown. Exclusion from the short-term numerical emissions limits for cold startup periods will not exceed 60 minutes per occurrence.
  - Warm Startup—Restarts made more than 8 but less than 48 hours after shutdown. Exclusion from the short-term numerical emissions limits for warm startup periods will not exceed 50 minutes per occurrence.
  - Hot Startup—Restarts made 8 hours or less after shutdown. Exclusion from the short-term numerical emissions limits for hot startup periods will not exceed 30 minutes per occurrence.
- Shutdown—The time the HRSG stack goes out of compliance during shutdown to termination of fuel flow to the GT. Exclusion from the short-term numerical emissions limits for shutdown periods will not exceed 30 minutes per occurrence.

Table 3-1. Hourly and Annual Emissions per CT during Normal Operations*

Pollutant	Maximum Hourly (lb/hr) With Duct Burner Firing	Maximum Hourly (lb/hr) Without Duct Burner Firing	Potential Annual (tpy)†
NO_x	29.19	26.57	127.85
CO	17.75	16.17	77.72
VOC	10.15	4.62	44.47
$PM_{10}/PM_{2.5}$	17.33	12.18	75.88
SO_2	4.35	3.97	19.04
H_2SO_4	2.67	2.44	11.71
Lead	1.87E-03	1.71E-03	0.01
GHGs CO_2e	463,110	407,522	2,028,421

*See Appendix B, Tables B-1 and B-2, for detailed calculations.
†Annual emissions (tpy per CT) are based on the maximum for 8,760 hr/yr either with or without duct burner firing.

Note: CO_2e = carbon dioxide equivalent.

Source: ECT, 2016.

Table 3-2 summarizes the duration of the startup and shutdown event.

Table 3-3 summarizes emissions (per CT) of NO_x, CO, PM_{10}/$PM_{2.5}$, and VOC during each event of startup and shutdown operations. Table 3-4 presents a summary of average annual emissions, including startup and shutdown emissions, for the proposed CTs. Appendix B, Tables B-3 and B-4 present detailed emissions calculations.

Annual emissions resulting from startup/shutdown operations for the proposed CTs are based on 10 cold starts per year, 40 warm starts per year, and 200 hot starts per year per turbine. Appendix B, Tables B-3 and B-4 provide additional details.

C4GT is proposing two alternate operating scenarios: tuning and water washing. Although short-term NO_x and CO emissions from operations covered by these alternate operating scenarios may exceed the maximum hourly emissions rates listed in Table 3-1, neither scenario will result in 24-hour average emissions rates (lb/hr) higher than the maximum short-term rate. Therefore, tuning and water washing will not result in higher annual emissions than those calculated in Table 3-1. Additionally, the CTs will comply with the Title 40, Part 60, Code of Federal Regulations (CFR), Subpart KKKK, NO_x emissions limit under all operating scenarios.

3.1.3 CT Generator Emissions: Maximum Annual

Annual emissions for the two CTs were calculated based on the maximum of either 8,760 hr/yr of steady-state operation or emissions, which include the maximum number of startup/shutdown events. The annual emissions during startup/shutdown include the appropriate downtime based on the assumed number of cold, hot, and warm startups and shutdowns. Tables 3-5 and 3-6 present the annual emissions (tpy) of PSD pollutants and HAPs, respectively, for the two CTs arranged in a 2×1 configuration for two cases:

- Continuous operations for all turbines 8,760 hr/yr per CT with duct burning (see Table 3-1).
- Continuous operations for all turbines 8,492 hr/yr with duct burning and 268 hr/yr in startup/shutdown conditions (see Table 3-4).

Table 3-2. Startup and Shutdown Duration (per CT)

Parameter	Natural Gas Firing (minutes)
Cold start	60
Warm start	50
Hot start	30
Shutdown	30

Source: ECT, 2016.

Table 3-3. GE CT Startup and Shutdown Scenarios, Durations, Emissions

Scenario	NO_x (lb per event)	CO (lb per event)	VOC (lb per event)	Total PM (lb per event)	Duration (minutes)
Cold start	273	840	60	12	60
Warm start	163	188	13	10	50
Hot start	105	180	14	6	30
Shutdown	18	100	65	8	30

Sources: Data provided by C4GT based on turbine vendor data, 2016.
ECT, 2016.

Table 3-4. Annual Emissions, Including Startup/Shutdown (Average per CT)

Operating Mode	Duration (hr/yr)	NO_x		CO		VOC		$PM_{10}/PM_{2.5}$	
		lb/hr	tpy	lb/hr	Tpy	lb/hr	tpy	lb/hr	tpy
Without duct burning	—	—	—	—	—	—	—	—	—
With duct burning	8,492	29.19	123.94	17.75	73.34	10.15	43.11	17.33	73.56
Cold start	10	—	1.36	—	4.20	—	0.30	—	0.06
Warm start	33	—	3.25	—	3.75	—	0.25	—	0.20
Hot start	100	—	10.50	—	18.00	—	1.35	—	0.60
Shutdown	125	—	2.19	—	12.50	—	8.13	—	0.94
Totals	8,760		141.24		113.79		53.14		75.36

Note: CTs may operate without duct burning. Table shows maximum emissions, which will occur with duct burning.

Source: ECT, 2016.

Table 3-5. CTs: Maximum Annual Criteria Pollutant Emissions

Pollutant	Potential Annual Emissions Rates (per CT)* (tpy)			2×1 Configuration Worst-Case Annual Emissions (Total) (tpy)
	Maximum Without Startup and Shutdown	With Startup/ Shutdown	Worst-Case	
NO_x	127.85	141.24	141.24	282.47
CO	77.72	113.79	113.79	227.58
VOC	44.47	53.14	53.14	106.27
$PM_{10}/PM_{2.5}$	75.88	75.36	75.88	151.76
SO_2	19.04	18.60	19.04	38.09
H_2SO_4	11.71	11.43	11.71	23.42
Lead†	0.01	0.01	0.01	0.02
CO_2	2,026,326	1,997,519	2,026326	4,052,652
Methane	38.22	37.67	38.22	76.44
Nitrous oxide	3.82	3.77	3.82	7.64
GHG Mass	2,026,368	1,997,560	2,026,368	4,052,736
CO_2e	2,028,420	1,999,583	2,028,420	4,056,840

*Annual emissions without startup and shutdown are based on the worst case, 8,760-hr/yr continuous operation with duct burner firing.

†For lead, emissions rates are based on the worst-case firing rate and the AP-42 emissions factor of 0.0005 pound per million cubic feet (lb/MMcf) for natural gas.

Note: CO = carbon monoxide.
CO_2 = carbon dioxide.
CO_2e = carbon dioxide equivalent.
GHG = greenhouse gas.
H_2SO_4 = sulfuric acid.
NO_x = nitrogen oxides.
PM_{10} = particulate matter less than or equal to 10 micrometers.
$PM_{2.5}$ = particulate matter less than or equal to 2.5 micrometers.
SO_2 = sulfur dioxide.
VOC = volatile organic compound.

Source: ECT, 2016.

Table 3-6. CTs: Annual HAP Emissions*

Pollutant†	Total 2×1 Configuration (tpy)
Formaldehyde	7.06
Toluene	3.98
Xylene	1.95
Acetaldehyde	1.22
Ethylbenzene	0.98
Propylene oxide	0.90
Benzene	0.38
Acrolein	0.20
Polycyclic aromatic hydrocarbons	0.07
Naphthalene	0.04
Other HAPs	0.07
Total	16.85

*See Appendix B, Tables B-10 through B-14, for detailed calculations.
†The highest ten CT HAPs in terms of annual emissions are presented in this table. The remaining HAP emissions are presented under the group "Other HAPs."

Source: ECT, 2016.

The maximum annual emissions for all pollutants except NO_x, CO, and VOC occur during 8,760 hr/yr of continuous operation.

3.2 Ancillary Equipment

The facility will include an 18-cell cooling tower, auxiliary boiler, fuel gas heater, emergency generator, and emergency firewater pump. Table 3-7 presents emissions concentrations of PSD pollutants and HAPs from the ancillary equipment, and Appendix B, Tables B-4 through B-14 provide detailed emissions calculations.

3.2.1 Multiple-cell Mechanical Draft Evaporative Cooling Tower System

The steam condenser cooling system will use a multiple-cell mechanical draft wet cooling tower. In the cooling tower, circulating water is distributed among multiple cells of the cooling tower, where it cascades downward through each cell and then collects in the cooling tower basin. The mechanical draft cooling tower employs electric motor-driven fans to move air through each cooling tower cell. The cascading circulating water is partially evaporated, and the evaporated water is dispersed to the atmosphere as part of the moist air leaving each cooling tower cell. The circulating water is cooled primarily through its partial evaporation. The cooling tower will be equipped with a high-efficiency drift eliminator with a drift rate of 0.0005 percent.

The cooling tower is expected to have a recirculating flow rate of 348,500 gallons per minute and maximum 6,250 milligrams per liter of total dissolved solids. PM_{10} was calculated by assuming PM_{10} is generated by water droplets with a diameter less than 100 microns, which account for 0.6 percent of the total suspended particulates (TSP) emitted from a typical cooling tower. Therefore, PM_{10} was determined by taking 0.6 percent of TSP. It was assumed that $PM_{2.5}$ is generated by water droplets with a diameter of less than 25 microns, which account for 0.022 percent of TSP; therefore, $PM_{2.5}$ was calculated by taking 0.022 percent of TSP. As documented in Appendix B, maximum PM_{10} emissions from the wet mechanical draft cooling tower are 0.033 lb/hr, and $PM_{2.5}$ is 0.0012 lb/hr. Assuming continuous operation, maximum potential annual emissions of PM_{10} from the cooling tower would be 0.14 tpy, and $PM_{2.5}$ would be 0.01 tpy.

3.2.2 Auxiliary Boiler

The facility will include a natural gas-fired auxiliary boiler that has a rated heat input rate of 105 MMBtu/hr. The boiler is being permitted without any operating restrictions. Therefore, annual emissions are based on 8,760 hr/yr. Table 3-7 presents emissions concentrations of PSD pollutants and HAPs from the auxiliary boiler, and Appendix B, Tables B-5, B-10, and B-14 provide detailed emissions calculations.

3.2.3 Dew Point Heater

The facility will have one natural gas-fired dew point heater. The heater will be rated at 16 MMBtu/hr. The dew point heater is being permitted without any operating restrictions. Therefore, annual emissions are based on 8,760 hr/yr. Table 3-7 presents emissions concentrations of PSD pollutants and HAPs from the inlet fuel gas heaters, and Appendix B, Tables B-6, B-10, and B-13 provide detailed emissions calculations.

3.2.4 Emergency Engines

The facility will have a 2,500-kWe emergency generator powered by a 3,633-bhp diesel-fired engine. In addition, the Project will include a 315-bhp diesel-fired emergency firewater pump. The diesel-fired emergency generator and firewater pump will meet the emissions requirements in EPA's Standards of Performance for Stationary Compression Ignition Internal Combustion Engines, July 11, 2006 (40 CFR 60, Subpart IIII). The emergency engines will also meet the requirements of 40 CFR 63, Subpart ZZZZ. For these engines, the only requirement under Subpart ZZZZ is to be in compliance with 40 CFR 60, Subpart IIII. The firewater pump and emergency generator are expected to operate for no more than 100 hr/yr for routine testing and maintenance and 500 hr/yr total, including emergency use, on a per unit basis. Table 3-7 presents emissions concentrations of PSD pollutants and HAPs from the emergency engines, and Appendix B, Tables B-7, B-8, and B-10 provide detailed emissions calculations.

3.2.5 Circuit Breakers

The proposed Project will include four switchyard circuit breakers and two low-side generator breakers. Each switchyard breaker will hold 1,900 lb of SF_6 per unit, while the smaller low-side generator breakers will hold 30 lb of SF_6 per unit. The total SF_6 capacity at the facility will be 7,660 lb. The SF_6 leak rate will be limited to 0.5 percent on an annual basis. SF_6 emissions (as

Table 3-7. Annual PSD Pollutant and HAP Emissions from Ancillary Equipment

	Ancillary Equipment(tpy)						
Pollutant	Cooling Tower	Auxiliary Boiler	Dew Point Heater	Emergency Diesel Generator	Emergency Firewater Pump	Circuit Breakers	ULSD Storage Tank
NO_x	—	5.06	0.77	6.73	0.36	—	—
CO	—	17.02	2.59	5.21	0.45	—	—
VOCs	—	2.30	0.35	2.88	0.16	—	1.27E-03
Sulfur oxides	—	5.41E-01	8.24E-02	2.43E-05	1.61E-01	—	—
$PM_{10}/PM_{2.5}$	0.14/0.01	3.22	0.49	0.30	0.03	—	—
Lead	—	2.25E-04	3.43E-05	5.72E-05	4.96E-06	—	—
H_2SO_4	—	4.14E-02	6.31E-03	1.86E-06	2.72E-05	—	—
GHG CO_2e	—	53,822	8,201	1,040	90	437	—
HAPs	—	4.05E-02	6.39E-03	2.86E-02	3.61E-03	—	—

Note: CO_2e = carbon dioxide equivalent.

Source: ECT, 2016.

carbon dioxide equivalent [CO_2e]) from this source are expected to represent only 0.01 percent of the facility's CO_2e emissions. Table 3-7 presents emissions concentrations of PSD pollutants and HAPs from the circuit breakers, and Appendix B, Table B-16, provides detailed emissions calculations.

3.2.6 Fugitive Methane and CO_2 Emissions from Natural Gas Piping

GHG emissions calculations for natural gas piping component fugitive emissions are based on emissions factors from Table W-1A of the Mandatory GHG Reporting Rules (40 CFR 98) for components in gas service for the Eastern United States. The concentrations of methane and CO_2 in natural gas are based on the natural gas analysis used as a design basis for the Project, as provided in Appendix B, Table B-16. The global warming potential factors used to calculate CO_2e emissions are based on Table A-1 of 40 CFR 98. Appendix B, Table B-16, provides assumptions, including the estimated inventory of piping components, and detailed calculations.

GHG emissions calculations for releases of natural gas related to piping maintenance and CT startup/shutdowns are calculated using the same methane and CO_2 concentrations as natural gas piping fugitives and are based on the assumptions and calculations detailed in Appendix B, Table B-16, with regard to the numbers and types of piping component system purges per year and the volume of each piping system.

3.2.7 Fuel Oil Storage Tank

The Project will include one 3,000-gallon ULSD fuel horizontal storage tank for the diesel-fired emergency equipment and one 400-gallon ULSD fuel horizontal storage tank for the diesel-fired firewater pump. As discussed in Section 4.4.4, NSPS Subpart Kb does not apply to the storage tanks because of the small size and low vapor pressure. Table 3-7 presents the VOC emissions from the ULSD fuel storage tanks, and detailed emissions calculations from the tank modeling (using EPA's TANKS 4.09d program) can be found in Appendix B, Table B-18.

3.3 Project Emissions

Table 3-8 presents the annual PTE of the Project, including the two GE 7HA.02 CTs and the ancillary equipment. Total HAP emissions from the Project will not exceed 25 tpy, and individual HAP emissions will not exceed 10 tpy as shown in Table 3-9 (see Appendix B, Table B-10 for details).

Table 3-8. Total Annual Project Emissions

Emission Source Description	Parameters (tpy)								
	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO	VOC	H_2SO_4	Lead	GHG CO_2e
CT 1	141.24	19.04	75.88	75.88	113.79	53.14	11.71	0.01	2,028,420
CT 2	141.24	19.04	75.88	75.88	113.79	53.14	11.71	0.01	2,028,420
Cooling tower			0.14	0.01					
Auxiliary boiler	5.06	5.41E-01	3.22	3.22	17.02	2.30	4.14E-02	2.25E-04	53,822
Dew point heater	0.77	8.24E-02	0.49	0.49	2.59	0.35	6.31E-03	3.43E-05	8,201
Diesel-fired emergency generator	6.73	2.43E-05	0.30	0.30	5.21	2.88	1.86E-06	5.72E-05	1,040
Diesel-fired fire water pump	0.36	1.61E-01	0.03	0.03	0.45	0.16	2.72E-05	4.96E-06	90
Circuit breakers									437
Natural gas piping									61
Fuel oil storage tanks (two)						1.27E-03			
Total project emissions	295.40	38.87	155.95	155.81	252.85	111.96	23.46	0.02	4,120,493
PSD major source threshold	100	100	100	100	100	100	100	100	100,000
PSD major source	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes
PSD significant emission rate	40	40	15	10	100	40	7	0.6	75,000
Proposed project subject to PSD	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes

Note: Facility is located in Charles City County, Virginia, which is designated as either unclassifiable or attainment for all pollutants.

Source: ECT, 2016.

Table 3-9. Facilitywide HAP Emissions

Emission Source Description	HAP Emissions*	HAP Major Source Determination	Proposed Project Major Source?
CTs	16.41	—	—
Ancillary equipment	4.45E-01	—	—
Facilitywide total	16.85	25	No
Facilitywide single maximum HAP	7.06 (formaldehyde)	10	No

*See Appendix B, Table B-10, for detailed calculations.

Source: ECT, 2016.